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C. HEIPERTZ-HENGST



EQUINE SPORT

WITH FEELING AND KNOW HOW

A GUIDELINE FOR HEALTH CHECK-UPS,
EXERTION CONTROL AND
CONTROLLED TRAINING

POLAR®

Equine Sport with Feeling and Know How

A GUIDELINE FOR HEALTH CHECK-UPS,
EXERTION CONTROL AND CONTROLLED TRAINING

BY C. HEIPERTZ-HENGST

TRANSLATED BY I. WILSON

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ISBN 952-5048-71-3

1ST EDITION, JULY 2002

PRINTED IN FINLAND

POLAR ELECTRO EUROPE BV FLEURIER BRANCH

AV. D.-JEANRICHARD 2, CH-2114 FLEURIER, SWITZERLAND

TEL: +41 (0)32 86290 50

FAX: +41 (0)32 86290 55

WWW.HORSEHRM.COM

LAYOUT / GRAPHIC DESIGN OULUN TYYPIT OY / FINLAND

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Introduction

For centuries people have enjoyed handling horses, and, as the horse is in generally no longer required to fill its roll as a beast of burden, these age-old traditions are particularly popular nowadays and enjoy a great diversity of disciplines.

A horse's health and well-being is the focus for every horseman and horsewoman, be it the owner, trainer, rider, groom, breeder or veterinarian. They all want to be assured that the horse is fit and well. Before you buy or sell a horse, before you exercise or train it, before any challenge you face with your horse, you require accurate and timely information about its health. The POLAR Equine Wellness Kit, together with this practical guide provides all the equipment and information you need and will help you to observe and interpret the vital signs of your horse's health. These signs should be checked as a routine part of day-to-day management.

The POLAR Equine Wellness Kit gives you an accurate measure of your horse's health and teaches you how to record and interpret the data. It can give you early signs of injury or health problems and help you make decisions which may be lifesaving for your horse, such as when to stop exercise or when to consult the veterinarian.

The POLAR Equine Wellness Kit gives you the hardware you need - the POLAR VetCheck heart rate monitor and thermometer - and the information you deserve - for responsible horse care and management.

The Polar Equine product used during work allowe the "online" controll of exercise load and offer multiple benefit for training optimatisation - as shown in the second and third part of the book.

Neil Craig, Mike Nunan and Christine Heipertz-Hengst, February 2001

Health Check-up



Health Check, Why?

One of the most important skills you can develop in attending to the day-to-day management of your horse is knowing how to check the signs that give clues about the horse's well-being. There are many such signs, ranging from those you can observe, such as taking note of the horse's general behaviour and attitude, to those you can measure physiologically, such as recording the horse's resting and recovery heart rate and its body temperature.

Any changes from the normal pattern for these signs may indicate illness, injury, or fatigue. By interpreting these signs on a regular basis, you will be able to monitor the general physical and mental health of your horse, and hopefully deal with minor health problems before they become serious.

To check the signs that allow you to assess the well-being of your horse, you don't need sophisticated equipment or complicated testing procedures. The POLAR Equine Wellness Kit provides all the equipment you need - the POLAR VetCheck heart rate monitor and thermometer. These items, together with your intuition, your 'horsemanship' skills and some very basic information, are the essential tools of the trade.

All you have to do is determine what is normal for your horse and practise monitoring the signs so that, firstly, you and your horse

are comfortable with the routine procedures and, secondly, you have confidence in your results.

The following functions and signs ought to be checked regularly.

Health Check-up, How?

1.1 Condition & Behaviour

The experienced horseperson has known for a long time that changes in a horse's behaviour and temperament can indicate immediate or impending problems. So the first step is to gain an impression of your horse's general attitude and condition.

You do this by checking if:

- Its eyes are bright and clear
- Its coat's shiny
- It moves with its normal gait and agility

Interpretation

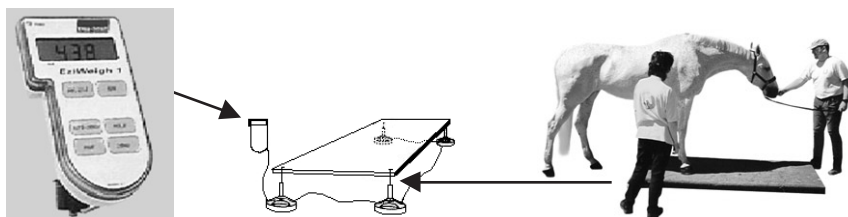
An increased amount of tail swishing or pawing, a reluctance to train, an inability to complete the prescribed exercise session, general irritability, and/or sluggishness are signs that should arouse your suspicion. These behavioural changes are particularly common in horses that are taking part in a rigorous training or exercise program.

1.2 Eating Patterns

'He's fine. He licked the bottom of the bin last night and at this stage seems to be 100%.'

Trainers or owners looking for warning signs regarding the general health of their horse will often make this type of statement. Here are some other points to check when monitoring the horse's overall dietary patterns:

- ✓ Are the gut sounds normal? Check the gut sounds by putting your ear against different points in the back region of the horse's trunk.
- ✓ Is the horse's manure normal? Is it well formed and colored? Does it smell unusual? Is it pale, too hard or too loose? Worse still, is your horse constipated?
- ✓ Monitor the bodyweight of your horse. Don't simply use your own visual assessment,



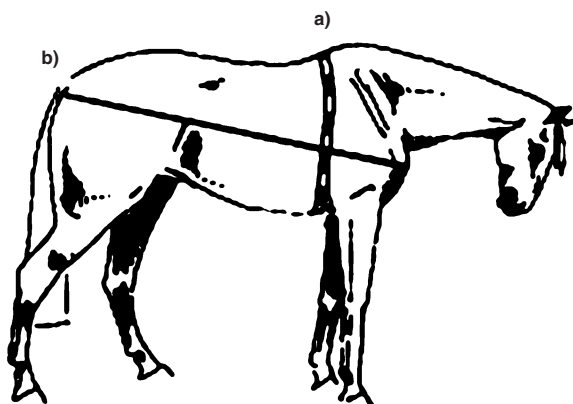
The picture shows the EziWeight;
you can buy it: Allié Agrartechnik, Benzstr.9, 63897 Miltenberg

- use one of two objective methods.

1. Horse Weighing Scales are simple and easy to use and no longer very expensive
2. Horse Bodyweight Formula (kg) =
Girth² (cm) x Body Length (cm) / 11,877

For example, if the girth and length of a horse were 180 cm and 190 cm respectively, the weight of the horse can be calculated as follows:

$$\frac{(180 \times 180 \times 190)}{11,877} = \frac{6156000}{11,877} = 518 \text{ kg}$$



How to measure :

(a) Girth: position the measuring tape just behind the point of the elbow and take it around the horse's body to the rear of the withers area. Take the measurement when the horse is breathing out.

(b) Length: measure the distance from the point of the shoulder to the rear point of the buttock, or rounded buttock curve.

Source - Frape 1896, Carrol & Hunnington 1988, Kohnke 2000

Interpretation

Any changes in eating or manure patterns or in bodyweight require control and a thorough check-up.

1.3 Body Temperature

A healthy horse will maintain its rectal body temperature within a fairly narrow range. Normal values for adult horses are in the range 36.5 - 38.5°C (98 - 102°F). Extreme day and night temperatures, exercise and excitement may change an individual horse's body temperature to a small extent, but body temperature normally remains within a tight range, even during these conditions. If your horse's resting rectal temperature is above normal, this may indicate disease, overheating or colic. A lower than normal rectal temperature may indicate shock or viral infection (similar to the 'chills' we feel with a viral cold). You need to be aware

that it is absolutely normal for your horse’s rectal temperature to be as high as 39.5 - 40.5°C after exercise. However, values above these are cause for concern and need to be investigated!

Polar Equine Thermometer



Measurement

The best way to measure a horse’s temperature is via the rectum using the digital thermometer in the POLAR Equine Wellness Kit. Lubricate the digital thermometer with a non-toxic lubricating substance (e.g. petroleum jelly, body oil) and insert the thermometer into the horse’s anus with a smooth contact to the skin of the rectum. Fasten the security clip and at the same time, listen for the beeping signal indicating that the temperature reading has stabilised. Remove the thermometer and read and record the digital display. These measurements should be taken in the morning, before exercise.

TABLE 1:

Day	Body Temperature (°C)
1	37.3
2	37.2
3	37.3
4	37.3
5	37.4

In Table 1, the resting rectal temperature of a horse over five consecutive days is recorded.

These measurements were taken in the morning before a training session. As can be seen the measurements are very similar when taken under standard conditions.

Interpretation

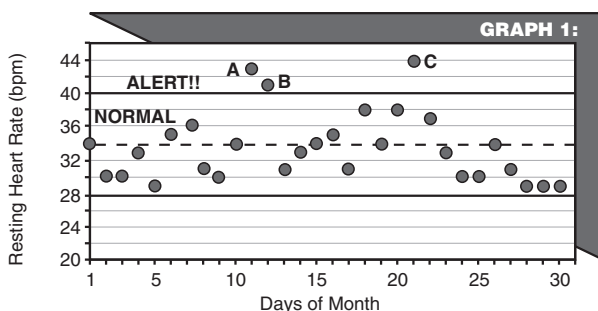
Deviations of more than ± 0.5 C° degrees from an established normal value should arouse your suspicion that your horse may not be well. Some infections do cause fevers that produce a normal temperature in the morning but an abnormally high temperature in the afternoon. If you are worried that your horse may be ill, it may be advisable to record the horse's temperature both in the morning and in the afternoon, and look for changes from the established normal value.

1.4 Resting Heart Rate

A horse's resting heart rate gives a clear indication of the general health of your horse.

The resting heart rate of a horse may be measured when your horse is standing quietly in a stall, stable, paddock or pasture. An adult horse's resting heart rate is usually in the range of 25 to 40 beats per minute (bpm). Measuring the resting heart rate in familiar and relaxed conditions is important because sudden excitement, fear, or anticipation of exercise can increase the heart rate rapidly to over 100 bpm.

In order to interpret the pattern in your horse's resting heart rate, you need to establish a benchmark. This benchmark is best achieved by measuring the horse's resting heart rate over 5 consecutive days and taking the average of these 5 measurements. For example, if a horse's resting heart rates are 27, 26, 29, 30 and 27 bpm for 5 consecutive days, the average is $27 + 26 + 29 + 30 + 27 = 139 \div 5 = 28$ bpm. Any subsequent measurement can be compared with this figure. Any resting heart rate 6 bpm higher than normal (in this example, more than 34 bpm) would suggest that your horse is undergoing some kind of stress.



Graph 1 plots the resting heart rates of an eventing horse over a period of a month. Its normal resting heart rate was established as 34 bpm. After detecting a high resting heart rate (Point A, 43 bpm) a decision was made to suspend training. The next morning, the resting heart rate was still elevated (Point B, 41 bpm). The horse looked lethargic and had a 'yellow' discharge from its nose. Once again training was cancelled. The horse recovered, but then just over a week later, recorded the highest resting heart rate for the month (Point C, 44 bpm). After examining other signs - legs, rectal temperature, respiratory rate, overnight eating pattern and the horse's general attitude, it was decided this high resting heart rate was simply due to the horse being agitated by the heavy rain on the stable roof that particular morning. Training continued with no subsequent problems!!

Before establishing your horse's normal or benchmark resting heart rate, you must ensure that your horse:

- ✓ Is healthy
- ✓ Is free of pain and injury
- ✓ Will have fairly easy training sessions during the 5 days when the measurements are taken
- ✓ Is used to having the POLAR VetCheck heart rate monitor put against its coat.

It is important to develop a routine so that the measurements are taken under similar conditions (i.e. before feeding, exercising or



The VetCheck grip-



-in use at the horse with
instant digital indication of
the horses heartrate

saddling). Once you have established this reference level for your horse, you should measure resting heart rate on a daily basis.

Another heart rate measurement used by some owners and trainers is 'saddled and ready to work' heart rate. In general, this heart rate falls between 36 and 48 bpm but, like resting heart rate, a benchmark should be determined for the individual horse.

An elevated 'saddled heart rate' may indicate impending disease, pain or psychological stress. A careful evaluation of other signs and factors leading to this abnormal measurement should be made before making a decision whether to continue the training session.

Some Practical Hints:

- With a horse familiar to the routine, you can take resting heart rate while measuring the body temperature.
- Make sure you record the resting heart rate alongside the previous day's training notes and any of your subjective observations.

Interpretation

If the resting heart rate is 6 beats per minute higher than normal, your horse is undergoing some form of stress. The stress may be caused by a hard training session the previous day, an injury that is not yet apparent, an impending infection (e.g. a cold) or a non-infectious problem such as colic. Whilst a significant increase in resting heart rate does not necessarily mean the horse should not be exercised that day, it would be wise to examine your horse fur-

ther before making a final decision. Check the “Quick References to Vital Signs” table on Page 18.

1.5 Respiratory Rate

Your horse's breathing rate is a clear and audible indication of its health and well-being. The respiration rate of an adult horse at rest is approximately 8 - 14 breaths per minute, with combined inhalation and exhalation making up one complete breath.

Respiration rate can be counted by observing the horse's nostrils or the movements at the end of the rib cage. The latter method is preferable. Breath rate per minute can be calculated by counting the number of breaths in 30 seconds and multiplying them by 2. The ratio of breathing frequency to heart rate is normally 1:4. Anything outside this range requires further investigation. Breathing should be calm and regular.

Interpretation:

If your horse has high resting breathing rates, it may be excited, in pain or ill. Body temperature may also be elevated (a sign you can now check and confirm). However, high environmental temperatures and humidity will also increase respiration rate, as the horse will adapt to these conditions in order to keep cool. Therefore, respiration rate is best used in combination with vital signs when assessing the general health and condition of your horse. It is also useful to check the quality and character of breathing (e.g. sound and effort) and discuss your observations with the veterinarian. You should also make sure you check your horse's nostrils to see whether they are clean and without discharge.

1.6 Blood Circulation and Water Balance

The condition of your horse's circulatory system is critical in determining its health. A useful tool for assessing the status of the circulatory system is **Capillary Refill Time**. Delayed Capillary Refill Time is often an indication of dehydration or low blood pressure, the latter normally caused by shock.

Capillary Refill Time is measured by pressing firmly with the finger or thumb on an area of the mucous membrane just above the teeth. This will result in the gum turning pale. After releasing the pressure, blood should refill the area and the normal 'pink' colour should reappear within 1-2 seconds.

Interpretation

Delays of more than 2 seconds are a cause of concern and delays of more than 4 seconds are considered serious. With delays of more than 4 seconds, any training or exercise should be cancelled pending a further check-up by your veterinarian.



So you do the Capillary Refill Test



So you do the Skin Pinch Test
or go on with text on page 30

1.7 Summary and Short Review with Reference Values

A technological aid like the POLAR Equine Wellness Kit is a complement to and not a substitute for the 'good feeling' of an experienced horseperson. The POLAR Equine Wellness Kit provides objective, accurate and immediate measurement of the horse's health signs - resting and recovery heart rate and temperature. Any change from the normal pattern in these and any other of the important signs outlined in this booklet may indicate that your horse has a health or injury problem.

Knowledge of your horse's usual signs can help you:

- decide whether to stop training and/or seek professional veterinary care
- detect a serious problem early in its development
- provide you with better horse care and stable management

It can also give the veterinarian a greater chance of a speedy diagnosis, successfully treating a problem and monitoring the horse's response to treatment.

The new POLAR Equine Wellness Kit offers grooms, riders, trainers and owners a quick and accurate method to complete a thorough health check of their horse.

It is an essential tool for the safe, effective and professional management of a horse.

TABLE 2: Quick Reference Guide: Vital Signs

Signs and function	GO	CAUTION	STOP
Behaviour	Bright, 'as usual'	Agitated, depressed, increased pawing and tail swishing	Dull, no interest, lethargic and reluctant to train
Eyes	Bright, clear	Glassy	Fixed stare, sunken eyeball
Hair / Coat	Shiny	Abnormal, sweating	
Impulsion	Free, willing	Stumble, short stride	Stiffness
Gait	Normal	Slight change	Consistent change, stiffness, unwillingness to bear weights
Eating /Digestion	Licks the bowl, drinking well	Leaves some food	Poor appetite and thirst
Manure	Well formed and coloured	Too hard/too loose, 'smelly' and pale	Urination / defaecation absent
Gut Sounds	Normal	Reduced / increased	Absent
Body Check	No visible marks	Heat / swelling / tender	Pain / raw / bleeding
Joints / Legs	No heat or swelling	Heat / swelling	Heat / swelling / pain
Back / Muscles	Relaxed	Tight / tender	Very tight / pain
Mucous Membrane	Pink / moist	Pale, tacky	Dry, purple, blue
Anal Tone	Tight	Slightly loose	Anus / penis relaxed
Resting Body Temperature	± 0.4° C normal value	± 0.5° C normal value	± 0.6° C normal value
Resting Heart Rate	± 2 bpm normal value	± 4 to 6 bpm normal value	> 6 bpm normal value
Recovery Heart Rate	< 64 after 10 mins	65 - 68 after 10 - 30 mins	> 68 after 30 mins
Resting Respiratory Rate	8 to 14 breaths / min, relaxed and regular	14 to 18 breaths / min, panting, inversion	> 18 breaths / min, laboured, abnormal sounds
Capillary Refill Time	1 to 2 secs	2 to 4 secs	> 4 secs
Skin Pinch Test	1 to 2 secs	2 to 4 secs	> 4 secs

Exertion Control

2

Exertion Control, Why?

The training of horses, riders and drivers is based on traditional knowledge, which has been modernized by teaching methodology, but scientific sports medical developments have hardly ever been integrated into it. This is particularly true for training, where, contrary to other sports, the control and direction of exertion as well as success in exercise is still due to “intuition”. Admittedly, a few methodological parameters have been added such as distance, speed, number and degree of difficulty of jumps and /or dressage lessons. Of course, every rider and trainer is attentive to the state of health of his or her horse and to its reactions during and after exercise - but we may also wonder how much sensitivity and experience, how much specialized knowledge and expertise are necessary to diagnose symptoms correctly and to react in time. This is what is meant by the real “horse sense” and horsemanship, which cannot be replaced by anything but which is not always self-evident and must be improved upon.

The following pages will explain how to optimize training through the use of heart rate monitors because strain and stress are recorded and easily readable. Intuition and experience are supplemented by facts, and the more or less subjective evaluation of the effort a horse has to furnish and its state of health becomes scientifically controllable. Another advantage is that the practical work undertaken by riders, jockeys and drivers can be recon-

structured. The observance and analysis of heart rate graphs help to establish individual values, which in turn allow the trainer to adapt exercises more carefully and more efficiently. By following and interpreting heart rate, the horse's exercise can be directed so as to get the best possible increase in performance with the least effort. The following explanation is an introduction to incite the reader's interest and to give a first basic information about the practical application of heart monitors.

Some basic physiological facts:

Physical performance in sport mainly depends on **muscular activity**. To be able to work permanently, a muscle needs sufficient blood, oxygen and food supply. The energy necessary for physical performance is produced through the increase in metabolism by burning carbohydrates and fats. How much energy is burnt depends on the intensity and duration of the exercise which the specific muscles are subjected to. As long as the oxygen supply is sufficient, combustion is **aerobic**, with the formation of water and carbon dioxide. If the oxygen supply is too low, energy combustion becomes **anaerobic**, thus creating lactates which may cause excessive acid level in the muscular structure, and this in turn will put a stop to the muscular activity. This means that for any physical effort energy has to be created by an increased transmission of oxygen and the elimination of carbon dioxide. The exchange of the supply in oxygen and the elimination of carbon dioxide depends on two related circuits: respiration and blood circulation. The lungs are the intermediary pumping station where the blood eliminates the metabolic waste in gaseous form and is again supplied with oxygen. It transports oxygen, together with other substrata and metabolic products, through the blood vessels to the specific parts of the body where combustion takes place. The heart, as a "pump", regulates pressure and volume.

Heart rate:

Through a complicated process, the "consumer" - in this case the muscular system - regulates heart rate and volume (the quantity of pumped blood). A comparison with a human will easily illustrate the enormous capacity of an equine heart. The pulsation of a human heart at rest is about 70 bpm, of an equine heart only 30 to 40 bpm. A human heart transports about 70 ml (a small glass

of wine), an equine heart nearly 1 litre. When subjected to stress and effort, human pulsation, depending on age and constitution, increases to values of about 180 to 200 bpm, equine pulsation to about 230 bpm. This indicates how much blood the heart can pump in a minute (in a given time unit) which can rise from 5 litres at rest to 20 litres, for a fit and well-trained athlete to more than 40 litres. For horses, the same values average 30 - 40 litres at rest and up to 240 litres during exercise!!

Influencing factors

A horse's heart rate informs the rider or trainer immediately about its state of health, its degree of training and its metabolic situation. Yet it must be remembered that both respiration rate and heart rate depend on and are influenced by physical effort on the one hand and by many other individual and environmental factors such as:

- breed, gender, age
- state of health and fitness
- psychological condition
- the unknown environment - the competition atmosphere
- the time of day
- the season
- altitude, climate
- atmospheric temperature and humidity, wind
- medication

These aspects must always be included in the evaluation and interpretation of measurements.

Exertion Control How?

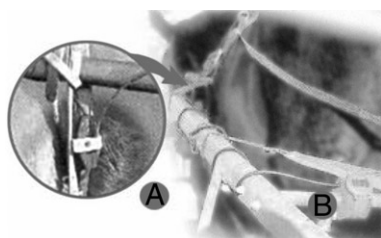
2.1 Equipment

The exact diagnosis of a horse should be completed by recording its heart rate. For this electrodes will be needed which transmit to a receiver the exact heart rate of the horse during exercise.

POLAR, the world leader in human sport, have developed heart monitors for horses which have been tested and improved in the

IAS Institute for Applied Sports Sciences, in collaboration with experts and veterinary research institutes. Flat electrodes, well tolerated by the horse's coat yet resistant and strong, are strapped on during saddling and harnessing and transmit the horse's heart rate to an easily readable watch-like monitor worn by the rider; a cable may connect the instrument to a monitor placed on the shaft of the sulky or on the seat of a coach. POLAR have also elaborated a special instrument indicating and recording speed during exercise. This fitness-meter indicates the horse's state and stress reaction under given circumstances, which are for instance its daily condition, or environmental factors like temperature and atmospheric humidity. Most POLAR monitors indicate the upper and lower limit of heart rate during exercise; a sound signal alerts the rider or driver to any excess either way.

Most impressively, physical effort is shown by a complete heart capacity graph. The easily operated monitors memorize the data and permit direct reading as well as the transfer of data by applying the instrument to an interface from where they are transmitted to a PC and can thus be analysed by special EQUINE software. This computer-assisted analysis of data permits their conversion into a diagram or numerical form, taking into account time and, if the necessary information is added, distance during exercise.



POLAR equipment attached to a sulky

In the next chapter we shall introduce further applications, for instance performance analyses and training diaries specially geared to equine sport. Let us now go over the important considerations for practical work:

Heart and respiration rates and other important physical reactions

during exercise, recovery heart rate, indication for fitness tests and daily routine work with heart rate control.

2.2 Exercise Heart Rate

In certain cases it may only be possible to establish a horse's heart rate through counting its pulse or with the help of a stethoscope. The horse must stand completely still at the end of exercise or during specially established intervals while an assistant checks its pulse, usually for 10 seconds (to be multiplied by six). Longer counts (15 seconds multiplied by 4), or shorter ones (6 seconds by 10) may be easier to calculate but often lead to distorted values and a high error rate. All these methods have the obvious disadvantage of starting at the end of the exercise and including the initial quick drop in heart beat in the intervals between counts. The real, continuous heart rate under exercise can only be established with the correct instrument.

Typical heart rate reactions of a horse under exercise

A horse's heart rates show, in addition to differences due to age and fitness, wide variations according to breed, (thoroughbred, halfbred, ponies) and other individual variations (size, character etc.). That is why it is advisable to establish the "normal" heart rate of any horse over a relatively long period by monitoring the same daily exercises and by repeating standardized tests several times. The following diagram can only suggest general values which must be related to the following important factors: The term "heart rate at rest" can only be used if the external conditions are unchanged during testing. We shall refer to the heart rate at the beginning of exercise as a "basic value", corresponding to more or less 30 - 50 bpm. Grooming and saddling already increases the heart rate, horses clearly show "pre-start reactions" in which their pulse increases to 100 bpm and more, a phenomenon entirely due to mental reactions. With physical exercise the pulse rate increases quickly and usually shows an exaggerated reaction at first, above all in untrained horses, which becomes normal after two to three minutes. Once the heart rate reaches 140 bpm, psychological factors no longer play a significant or detectable

role. If the heart rate remains the same with only minimal variations, an equilibrium has been established between the demand in energy and the supply from the blood circulation and metabolism. This condition is called the “steady-state” and is typical for a long steady effort, contrary to an exercise in which the horse has to keep on increasing its effort. The level of exertion at which the horse reaches the “steady-state” is all the higher the more difficult the task set in the exercise, and it may occur for peak performances if the horse is in excellent training.

When speed increases, there is first of all a linear increase in heart rate which lies between 140 to 200 bpm at a speed ranging between 350 - 700 metres per minute. Having reached a maximum heart rate of 200 bpm, the graph will flatten out, which indicates maximum strain and stress, even though the speed may increase further.

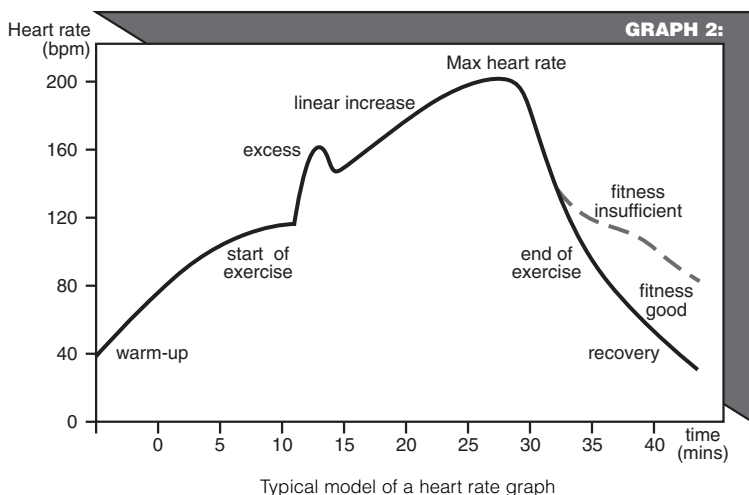


TABLE 3: Average values for equine heart rate

during exercise

Exercise	Speed			heart rate
gaits rating	metres/sec.	metres/min	km/hour	bpm
Foundation or basic exercises				30-50
Pre-start				40-65
Walking	1-2	125	6-8	50-91
Slow Trotting	3-4	250	10-15	80-125
Quick Trotting	4-5	300	15-18	100-160
Cantering	5-6	400	18-21	120-170
Gallop	6-9	500	24-32	160-200
Fast Gallop	13 +	600 +	36-48 +	205-240 +

2.3 Respiration under Exercise

Oxygen intake under exercise is the central and determining factor to judge the degree of effort and performance capacity. It is relatively complicated to establish oxygen intake through heart activity and blood checks, and direct measurements necessitate sophisticated technical means. But anybody can count the respiration rate to get an idea. The value can be established over 30 seconds at the horse's nostrils or better, at its rib cage, and then doubled. (This procedure, contrary to the pulse rate, takes into account the greater range of respiration). Though the method includes a relatively high error rate, the respiration count permits important conclusions concerning strain and stress, with however a strongly individual pattern. Reference values for respiration rate during the different paces only indicate range: walking about 60+/- /min; trotting about 75 + - /min; galloping 100 + - /min; racing speed 130 + - /min. Maximum respiration rate may exceed 180 respirations/min. Breathing is closely linked to movement; in full gallop, each jump corresponds to one respiration. "Gasping", a phenomenon that indicates excessive breathing, is not so much caused by great effort, it rather serves to get rid of over-heating caused by effort and environmental conditions.

It is no use to control respiration if the characteristic signs which

accompany it are not taken into account : decontracted, regular breathing is always a good sign, even if it is accelerated, while irregular, painful respiration with abnormal noises (rattling, whistling) represents an alarm signal and makes a check-up imperative. The depth of breathing - the volume of each intake of air - should be observed and repeatedly tested - immediately at the end of the exercise, one minute later and then ten minutes later, and the values should be compared. Breathing may remain accelerated for hours after a big effort or if regeneration capacity is insufficient.

2.4 Recovery Heart Rate

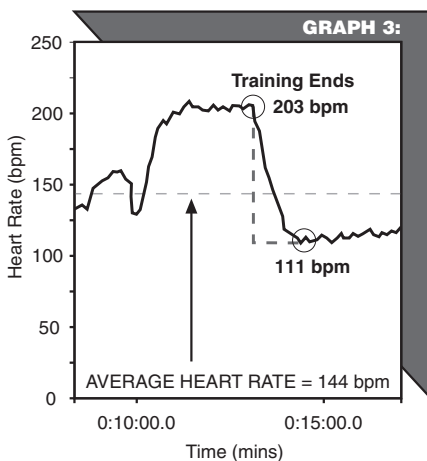
Immediately after the end of an exercise, a horse's heart rate starts falling; the decrease is particularly spectacular in the first 60 - 90 seconds, after that the graph flattens out. The process of the recovery rate gives, retrospectively, a clear indication as to the stress and strain undergone, the horse's fitness and state of health: the best sign is a fast and immediate drop to basic heart rate level. However, if the pulse clearly remains high even after 10 to 30 minutes (at the most), we may find ourselves confronted with intense physical stress, or the horse may be suffering from other problems such as pain, deregulation of its thermo-system or over-training.

Values established from experience have been used as indications for veterinary check-ups after long-distance rides:

- 10 minutes after end of exercise: heart rate less than 68/m:
→ ok
- 10 to 30 minutes after end of exercise: heart rate 68/m:
→ check-up required
- 30 minutes after end of exercise: heart rate over 68/m:
→ alert

In the last case, further heart rate controls are advisable after 60 minutes, and, if still too high, after 120 minutes following the end of exercise. By then, the heart rate should have approached rest values, even if a slight increase in the value may last for hours or

GRAPH 3

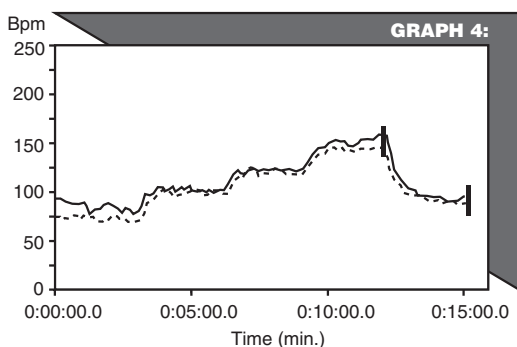


tant step is to determine the normal behaviour of an individual horse. That is why checks should always be carried out identically in order to be able to compare what is comparable. It is totally useless to compare the recovery values of different horses. **Only data comparisons of one and the same horse taken under exactly the same conditions can be taken seriously.**

If conditions are normal, reduced recovery capacity is a sure sign of stress, the beginning of sickness, lameness or worrying deficiencies which all need expert advice from a veterinarian.

Here are some examples from practical work life:

Comparison of two heart rate graphs of a horse



Graph No 4 shows the exercise and recovery heart rate of a horse in two identical training sessions which took place 4 days apart. The interrupted line corresponds to the “normal” course of galloping and afterwards walking; the continuous line established 4 days later indicates that the horse’s exercise heart rate was 11 beats a minute higher (156 instead of 145 bpm) and that the recovery rate after 3 minutes walking was 7 bpm higher (92 instead of 85). In the medical check-up to determine the reason for the difference, the horse was found to be slightly lame, though the lameness had not yet become apparent during training. Both front legs were iced and a veterinarian was consulted. As the early stage of lameness was not yet noticeable when the horse

was exercised, training might have continued. The monitoring of the recovery heart rate avoided a most likely worsening of the injury as the irregularity had roused the trainer's suspicion.

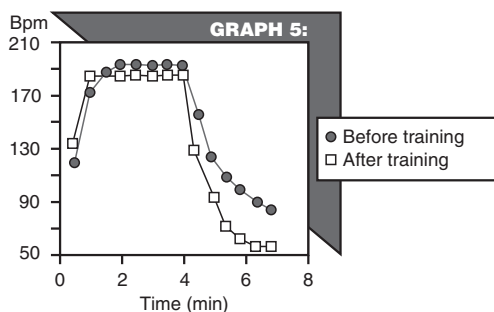
TABLE 4: Recovery heart rate over several days:

Day	5 min recovery heart rate
1	48
2	45
3	44
4	44
5	49

This record of the recovery heart rate (rhr) over 5 continuous training days belongs to the horse already known to us from graph 4. Every day the thoroughbred walked, trotted and cantered for 15 minutes, then walked back to the stable in about 3 minutes and stood still for 2 minutes while the saddle was removed. Heart rate was monitored with the POLAR VetCheck and the table shows the great similarity of the values which were established under standardized conditions.

Fitness Index:

In human beings, recovery heart rate diminishes as a result of training, highly trained athletes have a pulse of 55 bpm at rest, or less. As sports medical research for 4-legged athletes has shown, this tendency does not repeat itself in horses, at least not in the same way. This being so, what can be done to find evidence that the animal has become fitter? The only way is to measure the time necessary for the heart rate to return to normal after the end of exercise - in other words the recovery heart rate discussed in this chapter. The result of training will be that the time necessary will become shorter and shorter and the graph will show a steeper and quicker decrease. In other words: the faster and better a horse recovers, the fitter it is, as is shown by the following diagram.



Changes in time of recovery heart rate as a result of training

2.5 Energy Supply, Hydration, Body Temperature and Thermoregulation under Exercise

The processes of energy supply and transformation during physical exercise are multiple and directly connected to the different systems of respiration and blood circulation, food and hydration, digestion, and muscular structure. In this text we shall explain some of the particularly important aspects as to performance and effort control.

Time of energy supply - or when to feed:

Digestion itself needs energy and blood circulation, so it should not enter into conflict with physical effort which also needs energy. If energy concentrates are fed shortly before the beginning of exercise, the result will be fatal. For best energy distribution, well-balanced electrolytes* and for hydration, feeding should take place 3 to 5 hours before exercise, while water should always be available.

Hydration

A horse under exercise will sweat, sometimes abundantly. This does not only depend on physical activity but also on environmental conditions. Depending on the difficulty and intensity of the exercise, sweat loss may represent 0.75 to 5 litres of body mass and is a sure indication of the stress and strain the horse has undergone. There is a relatively easy way to test the quantity of liquid lost: the skin pinch test. It is imperative to realize that not only water but important mineral elements and electrolytes are

lost. Therefore, it is of great importance to re-establish not only hydration after a big effort but also to re-establish the acid basis as well as the mineral and electrolyte balance. Do not just trust the usual drinks offered in human sport but complete the salt lick with well-proportioned animal salts in trough fodder. (It is in any case advisable to seek expert advice for an exact and individualized diet for your horse.) Excessive exhaustion and dehydration necessitate a veterinarian's intervention who, among other things, and after laboratory tests, may inject specialized substances and who will supply liquid artificially by introducing a drip into the nostrils and throat.

*Electrolytes are minerals and elements whose electrical (ion) charge is essential for the functioning of energy metabolism and the muscular system. The acid basis refers to all organs.

The skin pinch test is an easy and quick way to test hydration levels. Take a fold of skin between the thumb and index or middle finger, twist it gently left and right without hurting the horse and then release. If hydration level is adequate, the skin will immediately snap back into place. You should test the skin near the shoulder, and maybe also at other parts of the body to be completely reassured, but always compare identical spots only. Also pay attention to the condition of your horse's manure and urine.

Interpretation:

If a skinfold remains for over 2 seconds, the horse suffers from slight dehydration (degree of dehydration 3 %). If the skinfold remains over more than 5 seconds, the horse suffers from heavy dehydration (about 10%).

Dehydration through lack of water or heavy sweat loss can also be diagnosed by the fact that the horse's manure will become dry, small and compact and its urine will take on a dark colour. In case of doubt, check the Capillary Refill time as indicated in chapter 1.6, p. 15 and compare with the general table on p. 18.

Body temperature:

Body temperature is another indication of stress and strain. Compare rest values with values taken immediately after exercise and record the time necessary to get back to the basic value. Physical activity always generates heat which is transported in the blood. Therefore, part of a heat rate increase during and particularly after exercise can be explained by the necessity of transporting heat as part of **thermoregulation**. Normal rectal temperature measured at rest lies around 37 C°; the temperature may increase under exercise by one or one and a half degree C and may even exceed 40 C° under maximum stress. An increase in temperature at the end of exercise is therefore normal, however values over 40 C° and long-lasting high temperatures should be interpreted as abnormal, in particular if there is the danger of heat retention through environmental conditions (like temperature, absence of wind, atmospheric humidity). Body temperature should be checked directly at the end of exercise and at least twice in 10-minute intervals, then hourly until normal temperature is reached.

2.6 Fitness Tests

We have already insisted on the fact that it is useful and instructive to establish your horse's heart rate fluctuations under daily exercise over a longer period of time and later on in regular intervals. It would be even more interesting and useful to record and compare them. On the other hand, if you really want to find out about your horse's fitness and to see if your training is correct and your horse adapts in the right way under your direction, you will need appropriate testing methods. "Testing" means always the same procedure, if possible, under the same conditions. This is called standardization. Only then can different tests be compared and changes in the horse's behaviour due to training be noticed and appreciated. You know by now that this includes the necessary warm-up work, which means following identical procedure and keeping to the same time of day. When interpreting tests, slight changes in the test situation such as weather, temperature, wind, terrain etc. should be taken into account and recorded.

Endurance tests:

Look for a suitable **course**, not shorter than 800 metres, not longer than 1600 metres. The track should conceivably be flat, straight or with wide, open bends, not too low-lying and therefore not weather-dependent. Ideally, it should have everywhere the same altitude, or, if this proves impossible, the track should lead uphill.

Test a):

Riding along the track should be accomplished at a good, regular speed. Establish the time necessary as well as the heart rate during the ride, at least the heartbeat at the end of the exercise. Then choose a certain heart rate as a reference value. As it is difficult to maintain a set value, allow a top and bottom limit to your chosen value.

At the beginning, it is easier to start with a wider margin, for about 160 bpm choose 170/150 bpm. Later on you can narrow the margin to 165/155 bpm. There is no need to look at the watch continually if you use a POLAR watch on which you can set a top and bottom limit, as you will be alerted by a sound signal if the chosen values are either exceeded or not reached. Watches with a memory will store these values and indicate them later as a guideline when printing the heart rate diagram. There is only one way to find out if your animal has improved under your training: Your horse is fitter because it needs less and less time for the test track, or it is able to run a greater distance in the same time. Yet despite the exertion it stays all the same within the heart rate limits you have chosen, which, after some time, both of you will find easier and easier to achieve.

Test b):

If you want to determine stress due to training by using a test track, you can carry out the test as a double speed test. In this case the track must be sufficiently long, at least 1000 metres. You ride along the track once as fast as possible and record the time needed together with the exercise heart rate; then, after a complete recovery phase of about 20 minutes, (which should always be carried out in the same way), you accomplish the same ride at a moderately fast speed, in other words far more slowly than before, and again record time and pulse. It is of course more precise to survey the complete process of the heart rate diagram and

- even better - to record it. The success of training over a relatively long period can be shown in this case because

- 1) the horse's heart rate will decrease though the indicated speed is maintained (time measurement)
- 2) the horse manages longer distances and a greater speed with the same heart rate.

Maximum heart rate (HR_{max})

For the last-mentioned test, your horse may have reached a speed which lies within the range of its maximum heart rate (HR_{max}). This value is of fundamental importance in the evaluation of the individual stress and strain of your horse occasioned by the exercise it is to undergo. Before explaining how HR_{max} is determined, let us mention some important facts concerning it:

The maximum heart rate of any horse - as of any human being - is genetically determined as it is a hereditary factor and cannot be altered with training. There are great differences between breeds and from one horse to the other. In human beings, heart rate diminishes in old age, more or less according to the formula: $220 \text{ minus age} = \text{maximum heart rate}$. Such an easy rule of thumb does not exist for horses, at least not yet, but it is quite realistic to count about $230 \pm 10 \text{ bpm}$ as a theoretical maximum.

The maximum heart rate of a horse is caused by physical effort and varies according to exercise, it is different for sprint training, for hill work or swimming. Medication can also alter HR_{max} , over-training and fatigue can lower it. It is not connected with performance potential. It would be totally wrong to suppose a better performance potential with an elevated maximum heart rate value, just as it would be mistaken to believe that a low HR_{max} value is a sign of lesser performance potential. Extreme endurance training may hinder reaching HR_{max} in speed testing.

Therefore maximum heart rate is not an absolute value but the individual highest number of beats per minute under certain forms of strain and effort. For a healthy horse, reaching maximum heart rate due to physical effort does not present a health hazard but rather indicates full use of its natural performance potential. It

allows us to establish a reference value, that is, a value to control exertion and to measure the difficulties of exercises. At the beginning and until you are sufficiently knowledgeable yourself, you should ask an experienced trainer or veterinarian for advice. They will check your horse's general state of health before determining its HR_{max} . Then you can rest assured that your horse will run no health risk through exercise and effort.

Test a):

Full use of performance potential over 1000 to 1600 metres: It is unlikely that such a distance test will induce a horse to peak performance when under training, it needs a real race with real competitive atmosphere. If you manage to monitor the heart rate during a race, or rather during the 20 seconds when your horse is at its maximum speed, the top value will be its maximum heart rate.

Test b):

Speed test with progressive increase: this test requires a slow step by step increase of the galloping speed, for instance every 400 m over a period of time of 2 - 3 minutes, until exhaustion. The following table is a representative example but it must be remembered that the speeds and distances chosen by you depend on the type and fitness of your own horse! Untrained horses will start relatively slowly! All the same, don't start too low, otherwise the test will last a long time before reaching maximum speed. Horses used to more training and thoroughbreds start straight away at a higher departure speed of 500 - 700 metres per minute. The first tests serve to establish the appropriate steps when to increase speed, and to set down your individually adapted test requirements. Only the last three steps should really be strenuous, and peak performance should only be maintained for 5 to 10 seconds. In our example below highest performance lasts for 6.5 secs. Maximum heart rate is reached at the last step which lasts only for a few seconds before the end of the test.

TABLE 5: Speed test: example of a continuous

**progressive speed test,
increased in 6 steps of 400 m each:**

Step	Speed	time to cover 400 m	Accumulated time	heart rate per min.
1	500 m/min.	48.00 s	48.00 s	174
2	550 m/min	43.50 s	91.50 s	188
3	600 m/min	40.00 s	131.50 s	193
4	650 m/min	37.00 s	168.50 s	201
5	700m/min	34.00 s	202.50 s	210

Test c): hill test

In hilly country it is often difficult to find a suitable flat track, so a different test may be helpful. However, the horse must be used to training in hilly environment before using such a track for a test. Easy, regular climbs call for longer test tracks, steep climbs necessitate shorter stretches. Preferably, you should reach the hill at a good basic speed which will be gradually increased until you reach the top, or until your horse gets tired. It would be ideal if the top value of the horse's performance would coincide with reaching the top of the hill. The heart rate at the end of the climb indicates $HR_{\max}$.

It does not matter whether you decide to use one or the other test possibilities - it is much more important to follow the following indications:

To achieve **standardization**, rules concerning warm-up and cool-down (see next chapter) must be kept to and the **feeding routine** maintained, that is, the last feed should consist in the usual food and be given 3 to 5 hours prior to testing.

Only well-rested horses are able to reach their maximum heart rate. On the day before the test, exercises should be easy; if your horse worked hard for one or two days before the test, or if it even ran a race, there is little hope to establish the correct maximum heart rate value.

If you have any doubts about the result, or if you want to be

absolutely sure about your horse's Max HR, repeat the test under the same conditions some days later to double-check the data.

CRI- Test - a combination of rest and recovery heart rate

Many veterinarians use the well-known and popular Cardiac Recovery Index or CRI-test in evaluating a horse's fitness. It involves the recording of cardiac rest rate with data about cardiac exercise rate 1 minute after the beginning of a specified work phase (exercise). As a control test it is often carried out after a race or exercise when the horse has been allowed to recover for 10 minutes.

CRI-Test Protocol

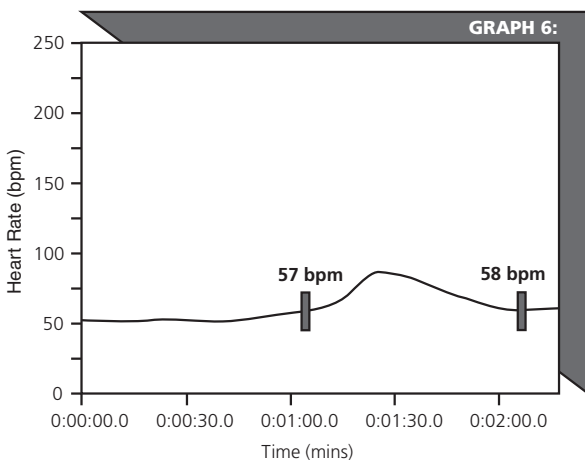
- Choose a flat, stable course of 80 m, 40 metres out, 40 m back.
- Measure the rest (or rather the basic value) of your horse's heart rate (using the POLAR VetCheck)
- Trot your horse, in hand, the 80 m distance start timing at the beginning of the trot and measure the heart rate exactly 1 minute later, (Your horse is likely to take 25-30 seconds for the 80 m distance and will be given 30 seconds to recover before its heart rate or pulse is again taken.)
- Observe your horse carefully during trotting for any signs of lameness
- Because the recovery heart rate (2nd measurement) is taken at a precise moment after the start of the trot, the test compensates for speed during the course. Horses that trot quickly have a longer recovery rate before the heart rate is measured than the ones which trot more slowly.
- According to an established criterion concerning a horse's fitness, recovery heart rate (rhr) should be 2 - 3 beats below resting or basic value heart rate.

A healthy and well-trained horse ought to be able to pass the CRI-test. By doing so, it shows that it has not yet reached peak performance level and that it is fit to continue.

Here are some additional hints for the interpretation of the test results:

- **Recovery heart rate is the same as or lower than resting or basic value heart rate**
 - **horse is fit to continue**
- **Recovery heart rate is 4 bpm higher than resting or basic value heart rate**
 - **horse has not yet fully recovered**
- **Rhr 8 bpm higher than resting or basic value heart rate**
 - **horse has not yet recovered completely**
Necessary measures should be taken to reduce stress. Rehydrate. If necessary, the animal should cease competition or workout.

If a horse is unable to pass the CRI-test after 30 minutes of recovery, it should not continue to exercise and should be carefully observed.



Graph 6 shows the CRI-heart rate-graph of an endurance horse. The horse cantered for 20 minutes with a heart rate of 140-150 b/m. It was given a 10 minutes rest period and then passed the CRI-test. Resting or basic value heart rate was 57 bpm, it peaked at 86 bpm, recovery heart rate after 1-minute 58 bpm - horse is fit to continue.

2.7 Training Routine with Heart Rate Control

Warm-up

Warm-up serves to prepare horse and rider mentally and physically for exercise or competition. Body and mind, emotions and nerves are made ready for effort and performance. This preparatory phase - a necessary step to increase performance - is essential to avoid injuries, in particular in the cold season.

Some important effects of warm-up

- increase of the heart rate
- increase of blood pressure
- expansion of heart volume per minute (the quantity of blood pumped in a minute)
- deeper breathing - expansion of the breathing volume per minute
- increase of body temperature
- increase of muscle temperature - the muscular system and

tissues (temperature, tension, blood circulation) are getting ready for exercise and performance

- quickening of metabolism
- regulation of nerve and hormone transmitters (release and messenger elements)
- higher attention
- greater motivation

From the point of view of sports science, the complete warm-up program should include 3 elements :

- gradual warm-up of the whole body
- simple mobility exercises
- calm and regular stretching

Before starting warm-up exercises as described in specialized literature, horses should be walked for at least 10 minutes - older horses even much longer!

To control stress during warm-up exercises heart rate monitoring is a useful aid (HEIPERTZ-HENGST, C. Pferde richtig trainieren. Cadmos Verlag, Lüneburg. 1999).

How long ?

Warm-up will take 15 - 20 minutes, more in cold weather, less in hot weather with high atmospheric humidity. Start gently and increase slowly.

How hard ?

Warm-up must not tire your horse! Experience has shown that warm-up exercises should be at about 50 - 75 % of maximum heart rate; this corresponds to preparation training.

An example: HR_{max} of a military thoroughbred lies at 230 b/min - preparation including walking, trotting, cantering should be at about 115 - 172 bpm. A few short bursts of fast galloping (not more than 400 metres) should be completed between 80 - 90% of the maximum heart rate, which means about 118-207 bpm in this case.

When ?

Warm-up must take place immediately before the start of the actual training session or race, there should only be a few minutes between the two activities. This requirement refers to the physical warm-up and not to the fact that your horse must get used to the environment and atmosphere.

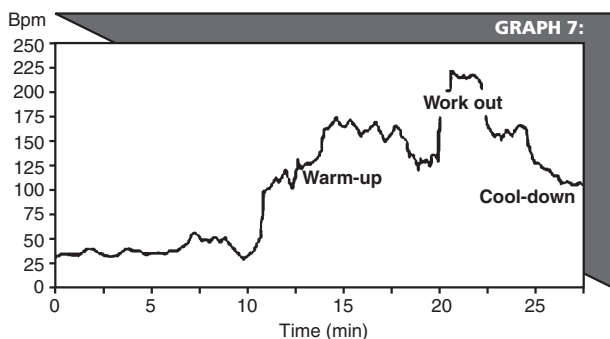
Common mistakes in warm-up:

There are two main mistakes: a) either **too little** or
b) **too much**

a) Everybody has experienced the phenomenon of “dead point” shortly after the beginning of a training session or a race. This period of time is limited to a few minutes of more or less marked loss in performance. It is accompanied by exaggerated breathing and sometimes by irregular leaps in heart rate. The cause of these symptoms may be that your horse’s blood circulation and respiration have not yet moved from rest to exercise rate during warm-up. All of a sudden it needs more oxygen than the body system can manage, in other words your horse experiences for a short time an anaerobic disturbance in its metabolism at the start of the required exercise. This unnecessary loss in performance can be avoided by careful warm-up with heart rate monitoring, which should be started gradually and slowly increased.

b) Too much effort during warm-up, on the other hand, uses up too much strength which will then be lacking for the training or race. This can happen quite easily if you rely entirely on “intuition” or if your own nervousness and inexperience needs reassuring by “pre-exercising”. (For instance too many jumps in the training area.) Another cause may be the trainer or rider who wants to make sure that his or her horse does not have to undergo too much stress during warm-up. They take the pulse by hand, and, invariably include the usual mistakes when counting, that is too much time between the interruption of warm-up and the beginning of the pulse rate control. Sometimes counting takes too long (more than 15 seconds) and the horse has already started recovering. In both cases the real stress and strain has not been correctly assessed. Wrong assessment is also due to mistakes in the actual counting, which usually indicate exaggerated pulse rates. Continuous heart rate monitoring solves the problem and allows

a retrospective performance analysis.



Total warm-up took 19 minutes with a 2 minutes recovery period before the beginning of the actual training session. The warm-up began with a 9 minutes starting-up period, followed by 3 minutes walking, 3 minutes trotting, 4 minute cantering. The horse did not go over 80% of its Max HR of 220 bpm. The workout phase for the training session lasted for about 1 minute as the trainer had prescribed a 1000m run. Highest performance level was reached after 45 seconds with a HR_{max} of 225 bpm.

Recovery and cool-down will be discussed in the corresponding chapter on p. 45

Workout phases and zones of stress and exertion

For clarity and sports medical reasons, stress and exertion have been classified in zones.

Zone 1: health and recovery / 50-60% of HR_{max} . This easy work phase is necessary to optimize basic physical activities. The zone applies for warm-up and later on for recovery (see corresponding chapter)

Zone 2: fitness / 60-70 % of HR_{max} . People often under-estimate the importance of this low-intensity exercise, yet it is ideal for starting training and as part of any training work as the required energy is supplied mostly by fat combustion. Moderate stress is sufficient, in particular if the effort required will go on for more than an hour, as it corresponds to the horse's natural inclinations.

Zone 3: aerobic level of work / 70-80% of HR_{max} . All basic

training for all disciplines should take place within this zone, which is unfortunately often neglected. General condition improves, in particular blood circulation and respiration. This is the correct degree of difficulty for relatively unfit horses and should remain a basic part of any training.

Zone 4: anaerobic level of work / 80-90% of HR_{max} . This zone optimizes the possibilities of lactate utilization and delays the threshold to increased lactate production, in other words the moment when oxygen deficiency becomes apparent. The result is improved performance potential for competitions, but this zone requires a great deal of experience from the trainer and should be accompanied by lactate controls. (See chapter concerning controlled training.)

Zone 5: maximum performance, 90-100% HR_{max} . Metabolism is highly anaerobic as the muscular system needs more oxygen than can be supplied. This phase should mainly be kept for races and then only sparsely, with adequate experience, in order to improve maximum performance if the horse's performance is high anyhow. The fixing of the individual HR_{max} of a horse is in itself a complete training unit. The following table (No 5) resumes and clarifies these points, table No. 6 is meant to simplify your work:

TABLE 5: Zones of training load

Zone	Rating	Main	Energy Purpose	System energy	% of HR _{max} supply
1	very easy	recovery/ health getting fit	aerobic	fat	50-60%
2	easy	fitness	aerobic	Optimal fat burning	60-70%
3	Moderate to hard	Performance Getting fitter (steady state)	aerobic	mainly fat carbohydrate	70-80%
4	hard	Performance increase	mixture of aerobic and anaerobic	mostly carbohydrate	80-90%
5	very hard	Competition top form (getting race fit)	anaerobic, or some aerobic	Highly carbohydrate	90-100%

TABLE 6: Equine Heart Rates as compared to Individual Maximum Heart Rates:

HR _{max}	90 %	80 %	70 %	60 %	50 %
240	216	192	168	144	120
230	207	184	161	138	115
220	198	176	154	132	110
210	189	168	147	126	105
200	180	160	140	120	100
190	171	152	133	114	95

Most “horsy” people, while training their horses, mainly think of the goal they want to reach: dressage, dexterity in jumping, adroitness on the shaft when drawing a carriage, and many other things.

Yet it would be most informative to connect these well-known aims to motor-related components: co-ordination, mobility, power, speed, endurance - how far are these different components put to contribution?

Daily training should be monitored, the heart rate graph should

be recorded and then interpreted together with the practical training work, such as lessons and special tasks. In endurance training the graph should flatten out, in which case you may be sure that the training session is taking place in the desired "steady state". This expression describes a relative equilibrium in metabolism between demand and supply, combustion and elimination; the stage at which it occurs is of no importance. It is useful to analyse your daily training work concerning load and how much time is spent in these zones. Before going on to useful hints concerning each discipline, we shall examine the heart rate performance graph of our demonstration horse described on page 42 and have a look at the last phases (graph 7):

Peak performance was to be reached in an interval of one minute which was made up of 15 seconds (= 25%) in zone 5, 30 seconds (= 50%) in zone 4, then 5 seconds in zone 3, 5 seconds in zones 2 and 5 seconds in zone 1 (in zones 3, 2 and 1 each 8.3% of stress).

Cool-down

Cool-down is as important as warm-up, yet it is still often neglected! Cool-down after training generally consists of cantering, slow trotting, then walking - and that is all. As we have seen, the recovery heart rate graph shows that important metabolic processes need to be stimulated and optimized, for instance the elimination of metabolic waste, (for example lactate elimination), and the careful changes in blood supply. Muscles exercised in training will develop stiffness and pain if they keep on being fully supplied with blood after the training session. Well-planned cool-down measures serve to start regeneration (reconstruction of performance reserves) and prepare for the next work phase - as has often been said, after one ride you start preparing the next. Cool-down should also be individualized, and heart rate monitoring offers the best control possibilities (see chapter 2.4, recovery heart rate, page 26 ff) for the same questions arise as for warm-up:

How much load and exertion? How intense?

It is evident that exertion should only appear in the aerobic zone as our aim is the rapid elimination of metabolic waste and not the creation of new metabolic products. Therefore, cool-down must

be within zones 2 and 1 (about 60-70% HR_{max}).

Intensive training with intense stress causes acidity in the muscular system, it is therefore advisable to include some careful exercises in the cool-down process. This means some additional trotting which keeps blood circulation and metabolism active and improves elimination.

How long?

If we consider these different facts, cool-down should last for about 10-15 minutes, and should then be followed by rubbing down and recovery.

If we take another look at graph No. 7, we can see that the horse cooled down for about 6 minutes. In this time the heart rate sank from the top value 219 to 106 bpm, which corresponds to a pulse decrease of 52%. The first quick drop levelled out for a short time while the horse was trotting, in the last minute its heart rate stabilized at about 106 bpm.

Regeneration

The last phase in cool-down consists in rubbing down, which should include checking for injuries and signs of overstrain. It is the beginning of regeneration, which - among other things - allows the horse to recover thanks to the ways of cooling down, to stabilize hydration level and to refill energy deposits with a suitable food supply. *

This is the moment when the horse adapts physically to the training, which ensures the success of the next training session. Insufficient cool-down hinders recovery and reduces adaptation. If the horse cannot cool down sufficiently, it cannot recover and adapt.

Your horse may also be suffering from muscle-ache and you may have to take appropriate physiotherapeutical measures.

* For further reading: C. Herpertz-Hengst, Pferde richtig trainieren, (How to train horses correctly). Cadmos publ., Lüneburg 1999)

Controlled Training

3

Controlled Training, Why?

Instruction and exercise improve a horse's mobility, while its performance in speed, power and endurance must be increased with the help of specialized training. From the preceding chapter we have learnt to control the training load our horse is subjected to. Now we must use this knowledge to set up an individualized training program and to guide our horse to success. Many trainers only find out after a race if their training was correct. Any training based on the horse's behaviour and competition results is retrospective and far removed from controlled training. The question: "Does my training have the desired effect?" should be asked much earlier. To answer it, we must formulate a clear **goal** for our instruction and training.

Trainers should remain realistic and view their own possibilities with a critical eye. First of all the level at which you begin - the present-state - must be established. To do this, you must recognize the whole situation:

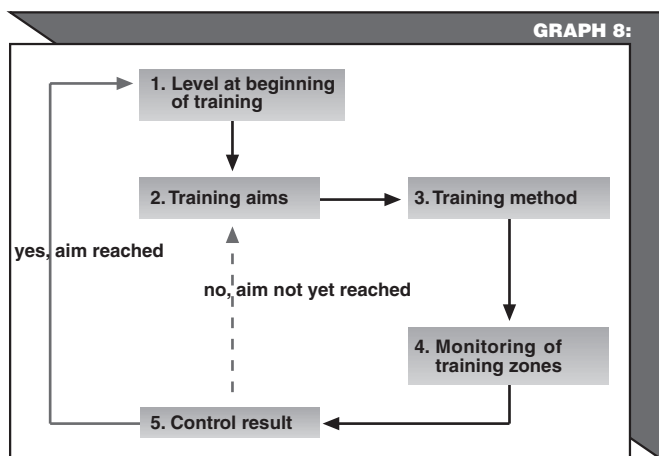
Your horse's true performance potential is biologically determined by genetic factors. Stabling conditions, feeding and activity can influence these aptitudes. A horse's inner "performance readiness" is of utmost importance. Find out about the present condition of your horse's constitution (health and performance potential), its fitness, the capacity it has reached in training, if it has already run competitions and its individual qualifications and experiences. What can you expect from the breed, age and gender? The list is not complete,

but it shows how important it is to know as much as possible about your horse. This knowledge allows you to determine what to aim at in training and to include these aims in your training program and competition planning. Controlled training, with short-term, medium-term and long-term control measures, ensures that the chosen training program is really put into practice, thus either confirming the method and dosage or suggesting immediate or future changes, corrections and fresh planning. Horsemanship, “the lucky hand” and intuition are primary conditions for any successful work with horses, yet these qualities should be completed with clear, scientific data to optimize the training schedule on every performance level.

A methodical approach should include all shown load control measures, which can still be improved by sports medical performance diagnosis. Therefore, if we admit that the real art of training consists in finding the right exercise in the right dosage at the right time, and in re-adapting it whenever required - then guided training will give you the necessary control and analysis system and will answer the question:

How do I find the least tiring and most efficient training level for my horse so that it will be able to reach its highest performance potential?

You will find the necessary information and important practical hints in the following chapter.



System of controlled training

Controlled Training , How?

3.1 Training Principles

A basic biological rule tells us that the structure and function of any organ are determined by the quality and quantity of the use it is put to. This means that organs and their functions adapt to effort by way of the metabolism responsible for built-up and maintenance. This explains why physical performance increases through systematic training. Some basic rules allow organisms to adapt to performance stimuli: The **quality of the training** program must correspond to the desired goal and stimulate the specific organs which will be put to work to achieve this goal. Speed training, for instance, increases muscular function and differs totally from endurance training which improves the functioning of the heart, blood circulation, breathing and metabolism; power training is again completely different. **The quantity of training** stimuli must be well thought out to determine how intense they should be, what their impact would be and at what moment they should be used.

Effort, load and strain must alternate with scheduled recovery periods, because it is in these periods that regeneration takes place and the horse adapts physically to the exercise to be able to increase its performance level.

Physical adaptation (structural and functional) to training takes place in the regeneration phase.

The most important training principles refer to :

- **quality of training**

training stimuli must be individualized and efficient

- **quantity of training**

training program - what?

training intensity - how intense?

training duration - how long?

training frequency - how often?

training schedule - how many rest phases?

This means in practice that

- the training program must be guided towards coordination, mobility, power, speed and endurance
- it should answer its purpose, be economical and efficient
- training stimuli must follow each other in the correct order:
 - first coordination exercises
 - followed by speed exercises
 - and then power training
- after that, there will be training for speed endurance and power endurance, its efficiency depends on incomplete rest phase arrangement;
- the final training exercises are for general endurance
- training stimuli must follow a correct program :
 - effort is increased, either gradual or in big steps
 - effort is continuous within a regular training series and
 - variable exertion exercises at different moments

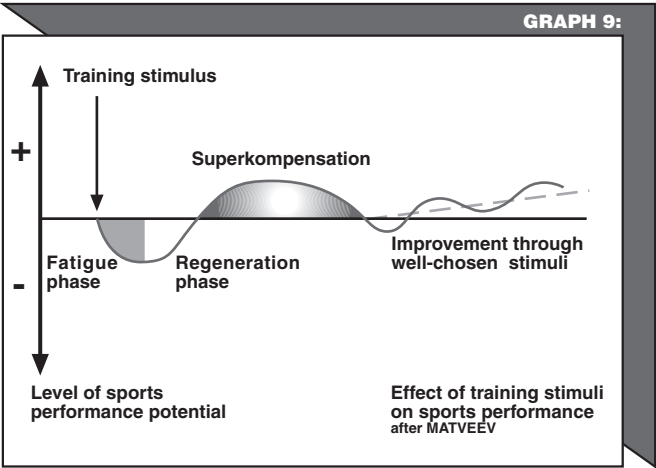
It is of course not necessary for all training units to be exercised in one training session, different points of the program should be applied at different moments according to their importance. Heart rate monitoring represents an invaluable aid for everyday work in the training for all disciplines.

3.2 Training Procedure

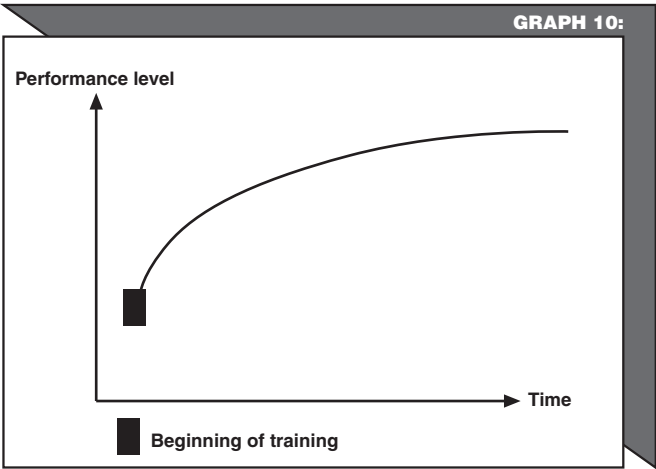
At first, when training starts at the horse's real performance level, any physical effort will exhaust its performance reserves and tire the animal.

During the then following recovery phase the horse regenerates. If the training stimulus was too weak, the result will be nul, if it was too demanding, it will cause exhaustion and sometimes damage. Only a perfectly adapted medium training stimulus will produce the desired adaptation. (Graph 9) The lower the training state is at the beginning, the faster there will be successful results, but the recovery phase will be all the longer. (Graph 10) In other words, fitness is recognized by a short recovery phase, yet further improvement will be relatively difficult. To stabilize adaptation structurally (in the organs themselves), and functionally (within

the program requirements), each training session needs time: If a lot of time has been spent on increasing the horse's performance, it will remain fit and adapted to training even in periods of little effort and reduced training.



Super-compensation



Graph showing performance increase

3.3 How to Plan Training

We always come back to the same question: **How hard should my horse work?** The following guidelines might help you to avoid the most frequent mistakes:

- Do not think that if you do a lot, you will get a lot!
Unnecessarily hard training causes energy problems, hidden damage and open injuries through chronic overtraining.
- If you do too little, you are also in the wrong! The hoped-for effects of your training do not materialize or only very slowly, your horse's performance does not increase sufficiently. That means fatigue and accident risk in competition.
- There is no such thing as a "success recipe" for all horses. Training should not be uniform as it often still is, unfortunately, in many disciplines. What is correct and successful training for one horse may be too much or too little or unsuitable for another one.

The time schedule should be based on several years or at least planned over a long period of time. It should be structured according to training periods, seasons and competition dates. It should be understood as a general framework which ought to be continually adapted and individualized through controlled training.

It is useful to take down written notes and to start a training diary for each horse. POLAR Equine software offers appropriate journals and date programs for different equine disciplines, for individual horses and/or stables and training communities. You will find further practical hints about how to plan your training in "Pferde richtig trainieren", Cadmos publ., Lüneburg, 1999.

3.4 Training Methods

As can be seen from the preceding lines, controlled training means individualization and adapting training procedures according to effort/stress and success controls. The following explanation of training methodology should be understood in this

sense and must not be used like a “cookery book”. They concern above all endurance training.

Heart rate monitoring to establish and direct effort, load and strain is a valuable aid in all training and essential for endurance training. Despite many other possibilities, there are principally two main methods:

Endurance training:

In this case the intensity of the effort is the same over a relatively long period. One should distinguish between

- basic endurance 1 = extensive training with
aerobic metabolism
- and
- basic endurance 2 = intensive training at the
aerobic / anaerobic threshold.

A rule of thumb says: the longer the distance - the slower the speed; the higher the speed - the shorter the distance.

Interval training:

This method divides training into definite work and recovery phases. A certain number of these continually changing units form series, and the whole training is a repetition of these series. Depending on intensity (quality) and duration (quantity), training is either aerobic or anaerobic. The expression “extensive” is used up to the aerobic/anaerobic threshold, while “intensive” interval training uses anaerobic energy production to a varying degree.

TABLE 7: Example of an interval training unit

Training protocol	extensive interval training aerobic	intensive interval training anaerobic
gallop intensity	400 metres/min	800 metres/min
gallop duration	2 min.	1 min.
interval	slow trotting - 2 min.	slow trotting - 5 min.
number per series	4 x	2 x
exertion - interval relation	1:1	1:5
recovery between series	trotting / pacing - 10 min.	trotting / pacing 15 min.
repetition of series	2 x	2 x
total exercise distance	6.400 m	3.200 m
duration of exercise	16 min.	4 min.

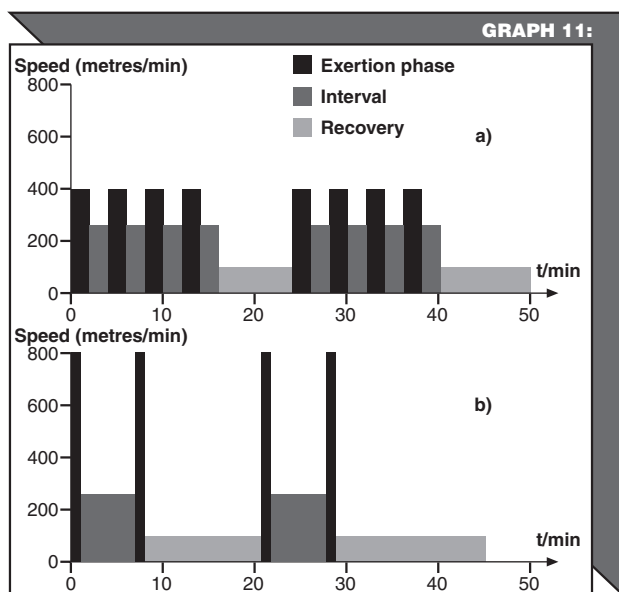


Diagram of an interval training unit

a) aerobic

b) anaerobic

To vary exercise or to calm horses which have become nervous through starts and stops during interval training, it is useful to try the following exercise: Ride your horse at all different speeds and paces while adapting to the terrain and observing its reaction to exertion, thus working in aerobic and anaerobic metabolic conditions. Using a heart rate monitor with a stop watch function will allow you to improve your own feeling for speed.

Establishing the intensity of exertion

Using the heart rate zones (p. 44) and analysing the heart rate graph during recovery, we can direct and control the intensity of exertion and apply the following basic rules:

- **If** heart rate under exercise does not exceed the selected top limit
- **If** recovery heart rate reaches the selected bottom limit during the rest phase
- **If** the horse is at ease, not tired, and walks steadily
- **If** the prescribed time, distance and speed were easily maintained, **then** continue with the next interval.

If not,

- decrease the requirements for the next interval exercise
- give your horse a longer break
- terminate the interval training unit and start cool-down.

At this stage it is useful to monitor the lactate content in order to make sure that, during endurance training sessions, we keep to an aerobic level of work and that we reach the targeted intensity during interval training.

3.5 Lactate Performance Graph

We have already mentioned lactate as the end product of anaerobic metabolism. If certain muscles are made to work intensively, the formation of lactate is a sign of lack of energy in the muscles concerned. Lactate is sent from its place of production to other parts of the body by entering the blood circulation and spreading all over the body. Lactate concentration is lower in the blood than in the working muscle, and in venous blood lower than in arterial

blood. Lactate is broken down in the liver, the muscular system not exercised in the workout, the heart and the kidneys. To establish a sports medical diagnosis it has been found useful to take a blood sample from the ven. jugularis in the horse's neck, which does not bother the animal. Measuring lactate content is, together with heart rate monitoring, the most frequently used way to control training, as it informs the trainer about:

- the efficiency of training - whether it took place at aerobic or anaerobic levels
- the consequences of the different intensity zones, it allows, in connection with heart rate and speed, a better adjustment in training zones
- the effects of certain training methods (for instance interval training) on the horse's metabolism
- the efficiency of exertion while using the different possibilities to exercise your horse - for instance lunge-line, exercise machine, treadmill, swimming
- establishing the real performance state (through blood lactate concentration after a race or workout)
- establishing aerobic performance

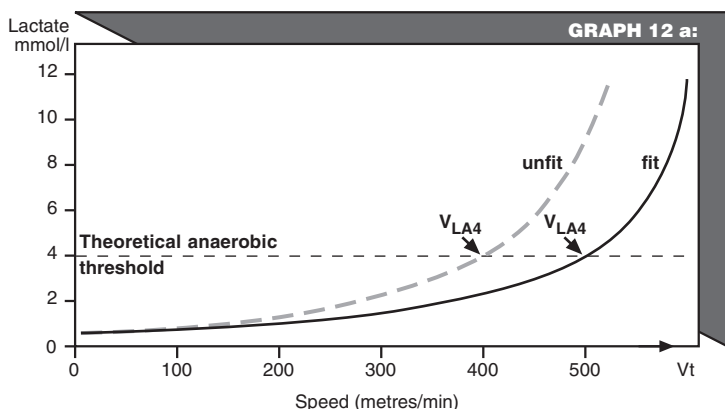
Lactate values should only be used for controlled training according to strictly standardized stepwise tests. The reference is the rest value, then at least four steps are used to assess the intensity of exertion, and finally the recovery values are taken in the 3rd, 6th minute, or, if necessary after some additional recovery minutes.

From these measurements we can establish **the lactate performance graph**. The information is all the more precise as more comparative parameters are added to the diagram: heart rate, time and speed or additional blood tests. Horses have a rest lactate value of about 1.5 mmol, under high exercise it may increase to 30 mmol! The extent and the development of the increase depend on the intensity and duration of exertion, and on the horse's fitness. Interpretation of the graph requires experience and should only refer to the one individual horse, under consideration of all concomitant circumstances. Unfortunately, it is still usual to transfer concepts from human sports medicine - where

they have often already been abandoned - to horses in order to determine the aerobic/anaerobic threshold. But there is no rigid threshold, which is still often set at 4 mmol and supposed to be equal to anaerobic metabolism. Anaerobic metabolism may occur in the same horse with different lactate values due to varying exertion and performances.

Aerobic/anaerobic and anaerobic thresholds must be determined individually for each horse.

It is always correct to say that higher lactate values indicate higher demands in energy. Under the influence of training the values found at one step change and the lactate graph flattens out and veers to the right.

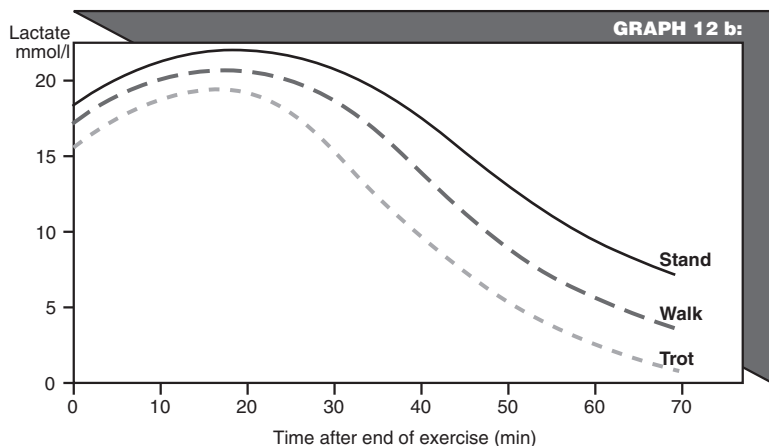


C. Heipertz-Hengst after Clayton/Hollmann

The lactate performance graph of a horse whose fitness has improved while exertion has remained the same: The graph shows the nature of the increase and indicates that the lactate curve veers to the right after improved training.

Training alters the lactate performance graph during the recovery phase as well. It should always be born in mind that peak performances produce peak lactate concentration only after the effort is over. A well-trained horse will eliminate lactate relatively fast and massively, and we have already said in the chapter concerning cool-down that lactate elimination can be accelerated with well-adapted movement during the recovery phase.

Beside establishing individual and maximum values to determine the aerobic/anaerobic threshold, these characteristic alterations of the graph are the best indication for a trainer to decide how to adapt the exercises for horses and put them into practice.



C. Heipertz-Hengst after Clayton/Hollmann

Different lactate elimination curves according to different activities during the recovery phase after intensive exertion.

3.6 Performance Diagnosis

Performance diagnosis to control training is made up of a long-term team work between rider, driver and trainer, veterinarians and scientists. Generally, the performance tests already described are carried out, but with even greater requirements for standardization and reproduction. Furthermore, physiological exertion-dependent data and laboratory parameters are included in the analysis. The check-ups on the working horse are undertaken by experts under laboratory and/or field test conditions.

Treadmilly

High-speed treadmills serve as ergometers, permitting standardized exertion in laboratory conditions. Thus the standards of test regulations are strictly maintained. The horse works with the ergometer without being influenced by the rider. Precision of

speeds (in m/s), distance (time) is guaranteed as much as the increase in exertion due to a per degree increase of the treadmill incline. From these values, exact submaximal (below peak exertion) and maximal tests (to exhaustion) can be established as endurance and stepwise tests. Ventilators are used to simulate the contrary wind which is missing in laboratories. However, a treadmill will change a horse's natural gait, which any analysis must take into account, as well as the fact that the horse has to get used to the environment. The high-speed treadmill offers ideal conditions for sports medical performance diagnosis and scientific research. Many of today's data used as reference values were gained in this way and modified in the field. Complicated additional tests, for instance continuous registration of blood pressure, of certain blood values or of breathing are only possible with the treadmill.

Treadmills do not depend on the weather nor on the terrain, they can be used for specially conceived training units and they can even be programmed. They have proved their worth for biomechanical training and for horses in rehabilitation which may only be trained on absolutely level ground and in strict doses.

Heart rate is of course continually monitored. It is even possible to adapt the treadmill automatically according to the heart rate.



Treadmill work - the heart rate is relayed to the command desk via the sulky cable.
(Note: There is nothing wrong with the quality of the photo - horses sweat heavily at treadmill work because of the absence of wind.)

Field tests

Field tests are carried out under natural conditions in a known environment, exertion is based on the requirements of competition discipline. On the one hand, this may give clearer results than a treadmill test in the laboratory, on the other hand standardization is much more difficult to achieve. A good test track is essential (see page 33) and is usually available on race courses. Speed control is ensured by markers and radio contact to the rider who should possess excellent speed feeling. When driving, speed can be established direct, when riding, GPS-systems (position via satellite) should be used.

We have already introduced a simple field test in the form of a two-speed test (often wrongly called two-track test). For this test, your home stretch must be sufficiently long - at least 1000 metres. Ride as quickly as possible along the stretch. Note the necessary time and heart rate during the ride. After complete recovery, at least 20 minutes (always carried out in the same way), ride again along the stretch, this time in a moderate to fast speed, that is to say, much more slowly than the first time. The training pulse to be established is the value in the middle region of the average heart rate value found to be necessary for the rides. It would of course be more precise to monitor the whole heart rate curve and, even better, to record and then to calculate it.

Stepwise tests can be pre-programmed on the treadmill and must be accurately planned in the field.

They are useful in order to establish lactate performance curves and must fulfil the following criteria :

- the number of steps should never be less than three, preferably four or, even better, six
- every step should last at least three, generally five minutes (for special tasks longer steps should be chosen)
- the degree of difficulty and exertion is increased at each step according to a definite program; the effort at the beginning and the increase in exertion depend on the fitness of the horse to be tested.
- only absolutely identical test procedures may be used to compare the results of different horses

- a horse's progress in training can be shown through the typical changes of the heart rate and lactate performance curves already described and can be used to control training-planning.

Competition tests

Competition tests may only be used to adapt and control training if all exterior factors can easily be analysed and are therefore comparable. Successful results in training do not always correspond to the horse's real rank and position, they must be compared to world class performance (peak standard) or to your own standards.



Preparations for an endurance test at the Frankfurt race course.

3.7 Heart Rate Reactions under Exertion Typical to Horsesports Disciplines

Dressage

Exertion in dressage-work mainly takes place with aerobic metabolism because these exercises do not require endurance performance - in particular power endurance - but coordination and biomechanical capacities. These faculties must be exercised and improved; they can be greatly increased by exercising basic aerobic endurance work (zone 1 and 2) together with medical pro-

phylactic assistance. As lessons become more difficult, the heart rate will go up (in the Grand Prix about 60 - 160 bpm), and, just like in humans, mental and psychological strain still increases this tendency. The same is true for all the following disciplines.

Jumping

During a course, a horse's heart rate increases to 150-200 bpm, depending on distance and speed as well as on the number and difficulty of the jumps. At the end of the workout, the blood lactate concentration of up to 6mmol/l shows an anaerobic metabolic partition which is likely to get higher with increasing difficulty. Both metabolic conditions (aerobic and anaerobic) will therefore be necessary for energy supply and should be exercised in training.

Eventing

A horse's physical exertion in eventing is as versatile and complete as single disciplines and demands specific training. Even the different stretches of the terrain test show completely different heart rates - during phase A and C about 120-135, on the race course 170-200, on the Q-track 140-200 hb/m; this gives a clear indication of the track profile, the difficulty of the jumps and the state of fatigue. At the end of the cross a blood test shows up to 12 mmol/l lactate, which indicates a high anaerobic metabolic condition. Training is therefore specially controlled and effectively assisted by heart rate monitoring.

The same is true for shaft or carriage horses, as the same single disciplines are exercised, that is dressage, obstacle and terrain drives, with various distances up to marathon. However, the exertion each horse has to furnish depends on the carriage (one or several horses) and on the horse's position in front of the carriage at the shaft.

Gallop races

For this performance, exertion depends again on the discipline - the length of the track may require sprinting, in other words rapidity, or endurance over a long distance. The metabolic processes react to demand and require enormous anaerobic capacities. Thoroughbreds may show a blood lactate concentration of 30

mmol/l after a race. Experienced trainers will find controlled training with heart rate and lactate performance graphs of great assistance.

Trotting

The reflections concerning gallop races apply to trotting as well. In this discipline it is of special advantage that speed can be easily established from the revolving sulky wheel and can be transmitted to the heart rate graph. The POLAR Equine Speed kit is solid enough to be attached to the sulky wheels.

Endurance races

Most distances for endurance competitions start with 25 kilometres and may go up to medium-sized races of 50 and even to long distance races of 160 km. A horse must be able to work economically and efficiently, the values recorded in the table may give an indication. Endurance riders in particular will appreciate continuous, easily readable heart rate control, because it is, together with pulse behaviour during recovery (for instance with the POLAR VetCheck), the determining parameter to check exertion. It is also the most important part of a veterinary check-up, together with lameness diagnosis and, if necessary, blood tests. During the regulatory stops the heart frequency must drop to 64 bpm after 20 minutes, if not the horse is not allowed to continue the ride or is disqualified. During intermediary stops, heart rate should reach 72 bpm after 10 minutes. In efficient training, speed regulation and stress and strain control through heart rate monitoring is self-evident and should be completed with lactate performance graphs.

Summary

4

The control of the exertion a horse is exposed to is best realized with heart rate monitoring and exact recording of the methods of procedure and exterior conditions.

Controlled training presupposes the analysis of the horse's fitness level at the beginning of training, the establishment of training goals and of a training program. It means a long, trusting cooperation between rider/driver/trainer, sports scientist and veterinarian. Performance tests may only be used to control exertion if they have been standardized and carried out at regular intervals.

It is important never to neglect to record the following parameters: Exterior and interior conditions, methodical exertion control (the training program with indication of distance, pace and speed, information about uneven ground, heavy soil, obstacles etc.) including the subjective judgment of the rider, driver and trainer. However, in addition to this it is essential to determine physiological reactions to exertion. To be able to recognise the individual aerobic/anaerobic threshold or rather to observe the metabolic situation during and after exertion requires the establishment of blood lactate values. We have shown in this essay that continuous heart rate monitoring represents a reliable indication of exertion and fitness; it is therefore useful for performance diagnosis and controlled training without necessitating any great technical or sophisticated apparatus.

Further Information

5

The Authors:

Neil Craig and Mike Nunan have 20 years of experience in preparation of human athletes and the application of scientific training information to international sport. During the last 5 years they have been involved in developing and monitoring training programs for standardbred, thoroughbred, eventing and endurance horses. More recently they have developed programs on how to maximise the potential of horses using the POLAR Equine Heart Rate Monitor. (Heart Rate Training for Horses)

Dr Christine Heipertz-Hengst is an active rider in the following disciplines: eventing, jumping, dressage and racing, she is a certified amateur riding instructor and A/FN trainer. After studying at the Pädagogische Hochschule Niedersachsen (Pedagogical University of Lower Saxony) and working for several years as a teacher at different school levels, she undertook to study sports at the Deutsche Sporthochschule Köln (The German Sports University, Cologne) and is now a qualified sports scientist in sports medicine (cardiology and rehabilitation). She now works in sports medical research for human and equine sport and has published a great many texts on the subject.

She has founded and directs the IAS Institute for applied sports sciences for research, product development and testing as well as for teaching and training in equine sport. Other important points of her work are prevention, therapy and rehabilitation of rider and horse.

The IAS Institute for applied sports sciences :

- * offers an expert team with the knowledge and technology for performance diagnosis
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Mozartstr. 18

D 65779 Kelkheim

Tel & Fax +49-6195-73967

E-mail: Heipertz-Hengst@em.uni-frankfurt.de

www.ias-service.de

RECOMMENDED ADDITIONAL READING:

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Polar Electro Europe BV Fleurier Branch
Av. D.-Jeanrichard 2, CH-2114 Fleurier, Switzerland
Tel: +41 (0)32 86290 50
Fax: +41 (0)32 86290 55



6 417452 110531

ISBN 952-5048-71-3